Analysis of Panamanian DMSP/OLS nightlights corroborates suspicions of inaccurate fiscal data: A natural experiment examining the accuracy of GDP data

Andrew Marx[a,*], Melissa Ziegler Rogers[b]

[a] Spatial Sciences Institute, University of Southern California, Los Angeles, CA, United States
[b] Department of Politics and Policy, Claremont Graduate University, Claremont, CA, United States

ARTICLE INFO

ABSTRACT

Governments have incentives to misreport their economic productivity to advance their political goals. These incentives have long been understood, but the validity of government data has been difficult to estimate in the absence of viable external estimates. Using historic Defense Meteorological Satellite Program's Operational Linescan System nightlights imagery we corroborate reports that Panama's government data has been increasingly politicised since the handover of the Panama Canal on 31 December 1999. The Canal Handover represents a "natural experiment" in which the production of government data changed in Panama for reasons separate from the desire to manipulate that data. The amount of light a country produces at night, known as nightlight production, has been shown to strongly correlate with GDP. Using subnational Panamanian nightlight production from 1996 to 2012, we detect a significant divergence between the relationship of subnational reported GDP and nightlights before the Canal handover (when the U.S.A. was very involved in their statistical agencies) and the correlation after the handover (with no U.S. involvement). Our results indicate that between 2000 and 2012, Panama reported approximately 19% more GDP than what was expected by their nightlight production from 2000 to 2012, or a total of around 40 billion U.S. dollars. Our results suggest governments may engage in political manipulation of government statistics to improve the appearance of government performance. While indirect data can never definitely confirm economic phenomena, this analysis presents a unique research design and application of historic satellite imagery to corroborate reports of GDP misreporting.

1. Introduction

Governments have incentives to manipulate their economic data to demonstrate good management of their economies. Nearly all economic data is produced by the governments themselves, making it difficult for scholars, investors, and policymakers to independently verify the accuracy of reported numbers. In this article, we demonstrate a possible technique, using satellite-based measures, to estimate changes in economic productivity and politicization of government statistics with external data.

Building upon a growing literature in economics and political science showing that reporting of gross domestic product (GDP) is at times under- or over-reported, we leverage a dataset of satellite-based historic nightlight production to detect this suspected underreporting of Panamanian subnational GDP (Chen and Xu, 2015; Alt et al., 2014, Wallace, 2016). Panama's government statistics and economic measurement were subject to considerable oversight by the United States

during the period prior to the handover of the Panama Canal to Panama on 31 December 1999. The strong interest of the United States in managing information related to its territory, military interests, and fiscal extraction from the Canal Zone was largely removed with the handover in 2000. We argue that the Canal handover to represent a natural experiment in which the reporting of GDP will be different in the pre- and post-handover periods, as Panama has the increased ability to bias its government data for political purposes. Reports of GDP are anticipated to be substantially overreported after 2000 due to the increased ability of politicians to use government data for political purposes.

Research in the social sciences has increasingly used nightlight data to measure economic productivity where GDP is assumed to be misleading or biased (Hodler and Paul, 2014; Harbers, 2015). Standard GDP data accumulated by agencies such as the World Bank and the International Monetary Fund (IMF) are produced by national governments that may have political incentives to misreport (Alt et al., 2014).
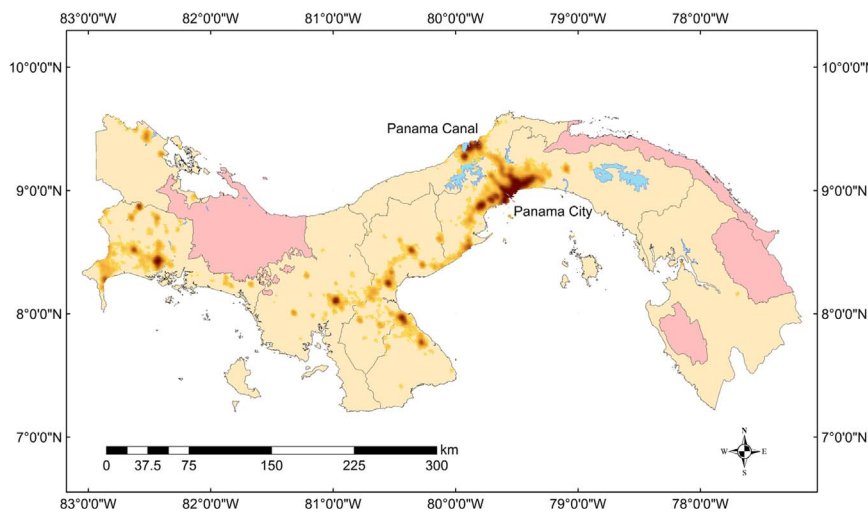

Fig. 1. The study area (beige) consisted of the nine Panamanian provinces. Inland lakes (blue) and indigenous regions and sub-provinces (rose) were not included. Panamanian nightlight production in 1996 is shown from yellow (lowest = 1) to red (highest = 63) was concentrated in Panama City and the adjacent Panama Canal and Colón Free Trade Zone.

For example, both China's national and sub-national GDP estimates have been shown to be systematically over-reported (Wallace, 2016). Moreover, many developing nations have large informal economies that make the accurate estimation of GDP challenging even where statistical agencies are not politicised (Wu et al., 2013). Nightlight data thus offer a reasonably objective measure to capture GDP levels and growth in data-poor environments.

Existing research has typically taken for granted that nightlight data will accurately capture economic productivity without strong research designs to estimate the accuracy of that relationship. The most common approaches are correlational, cross-sectional, and based on national-level GDP values. These approaches cannot account for systematic variance between GDP and nightlight values over time and within nations that may have very important economic or political significance. We know, for example, that nightlight values would substantially underestimate GDP in natural resource-based economies because agriculture and resource extraction are not electricity intensive. On the other side, GDP values would fail to capture informal economies and illicit activities that nightlight data may observe more easily. Overall, scholars will have a difficult time evaluating when, where, and why GDP and nightlight data might diverge based on correlational studies of national-level GDP. We focus on Panama to implement a research design that highlights why nightlight and GDP data might systematically diverge, using more fine-grained sub-national data and a specific time period in which we have theoretical reasons to expect these values to deviate.

2. Research approach

The Defense Meteorological Satellite Program's Operational Linescan System (DMSP/OLS) detects and records the brightness of the Earth's surface at 1 km pixels, or squares. This imagery was produced by the United States Air Force Weather Service to operationally monitor weather patterns for flight operations (Kramer, 2012). Today this data is aggregated into an annual product that controls for fires, clouds, and satellite differences, producing a stable time-series dataset of nighttime brightness from 1992 to 2013 (National Geophysical Data Center, 2013). This dataset has been demonstrated to be useful in a variety of applications including the detection of urban extents and population density (Sutton, 1997), greenhouse gas emissions (Elvidge et al., 1997), and rural electrification (Min et al., 2013). Increasingly, nightlights are used to evaluate and track specific phenomena such as humanitarian disasters (Henderson et al., 2009) or the impact and spread of conflict (Li et al., 2015; Witmer and O'Loughlin, 2011).

Nighttime light production has also been shown to strongly correlate with economic activity (Henderson et al., 2009), has been shown to

be an effective proxy to measure GDP for economies in transition (Feige and Urban, 2008), and to document regional favouritism in autocratic countries (Hodler and Paul, 2014).

These applications rely on using a signal detected in nightlight production as a proxy for detecting a phenomenon. For example, a sudden decline in brightness over a city may be linked to the presence of military conflict in that city. While the accuracy of using nightlight production as a proxy in these applications can be assessed with ancillary data, such as eye-witness accounts, remotely-sensed data are best used in applications where direct observation or data are not available, or used as an independent variable to evaluate existing data. In this research, we employ a time-series analysis of nightlight data and reported subnational GDP as independent means to evaluate claims that Panama's GDP estimates have become less reliable after the Canal handover at the end of 1999. This analysis is not meant to definitively prove politicization of government statistics, but to help inform and corroborate claims of Panamanian governmental corruption and data manipulation.

3. Study area

The Republic of Panama (Fig. 1) is the southernmost country of Central America and North America. Panama comprises 30,193 square miles and is divided into nine provinces, three indigenous regions, and two sub-provinces. The study area consists of the nine Panamanian provinces: Bocas Del Toro, Chiriquí, Coclé, Colón, Darién, Herrera, Los Santos, Panamá, and Veraguas. The three indigenous regions and two sub-provinces were not included because subnational GDP data are not available. Because these regions have significantly lower population and economic production than the nine provinces, their omission does not significantly affect the ability of this analysis to describe all of Panama.

4. Methodology

The input data for the study includes subnational GDP reporting from the Panamanian government, annual worldwide night time light production coverage from 1996 to 2012, and the land area of Panama's nine provinces.

4.1. GDP data

Subnational GDP data from 1996 to 2012 were obtained for Panama's nine provinces (Panamanian National Institute of Statistics and Census 2016) (Table 1.) Beginning in 1996, the Panamanian national statistical agency collects and compiles these data on a yearly